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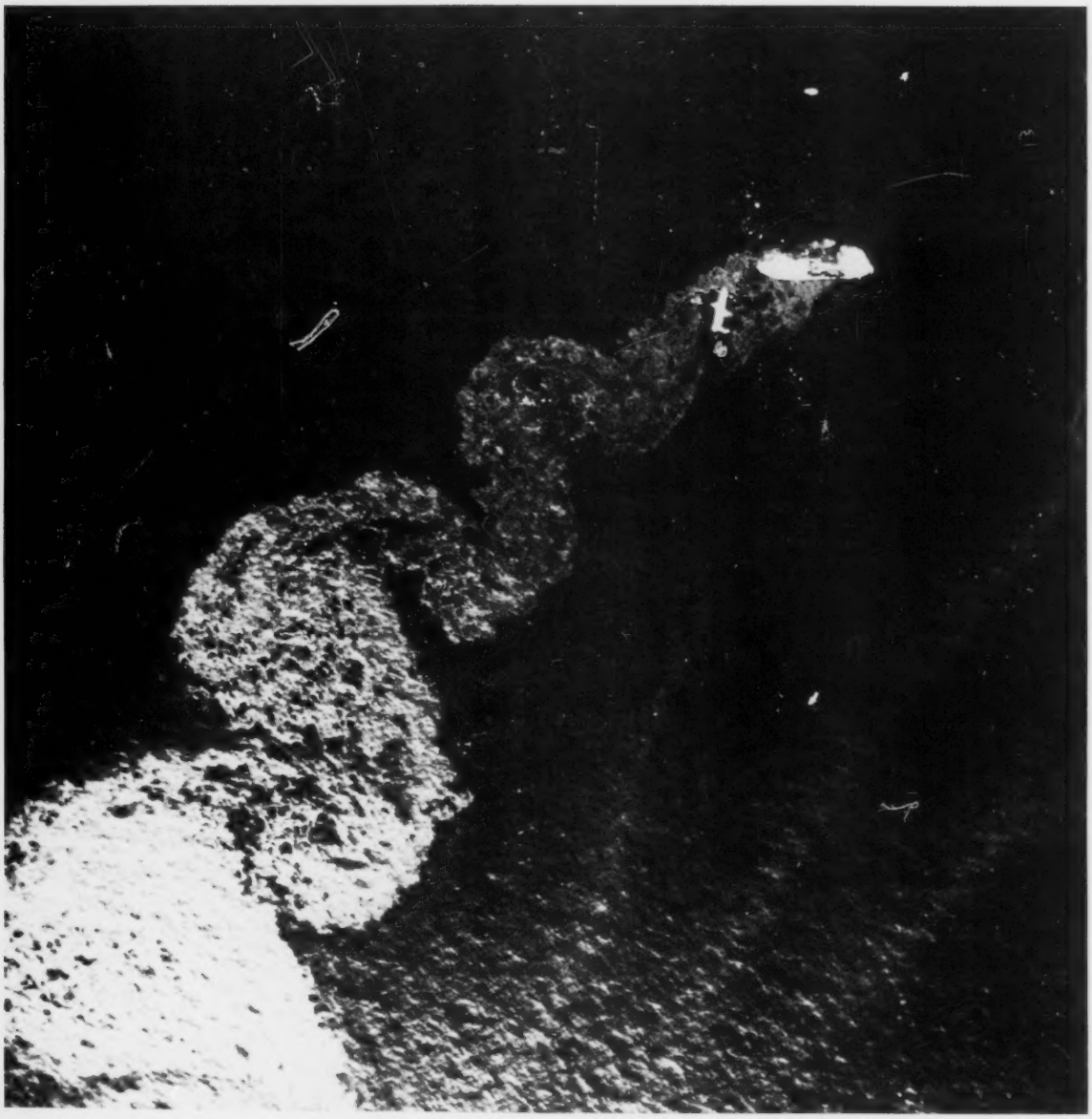

"Worst" Oil Spill off U.S. Atlantic Coast—As December waned, ecologists were trying frantically to cope with the huge amounts of oil spilled by the Liberian tanker *Argo Merchant* off the Massachusetts coast. NASA, through its Langley Research Center, went to the aid of the U.S. Coast Guard and the National Oceanic and Atmospheric Administration in their efforts to assess the extent of the spill by supplying aircraft and satellite data. This photo was taken by a Wallops Flight Center aircraft flying at 1,675 meters (5,500 feet) above the ocean near Nantucket Island, on Dec. 19, shortly before the vessel broke in half. Visible is a Coast Guard cutter attempting to help the stricken ship. The white dots at top and in middle of photo are helicopters.

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Letter from Washington

Dear Colleagues:

The beginning of a new year is a time of anticipation, opportunity and necessarily some uncertainty. It is a time to put the accomplishments of the past behind and open the door to the future.

One of the most significant beginnings of the coming year will be the Shuttle orbiter approach and landing tests which start next month at the Dryden Flight Research Center. In these tests the Shuttle orbiter will be airborne for the first time, not under its own power but flying nonetheless. Although the tests are designed to ascertain the air worthiness of the orbiter in the atmosphere, I suspect that they will also lead to an increased public awareness of the new space transportation system and the wealth of opportunities it represents for the nation and the world.

All beginnings include some uncertainties, but it is possible and desirable to reduce their impact and to achieve a better understanding of what the future may hold.

Last year, for example, an extensive institutional assessment was held to define more clearly the roles and missions of the NASA centers. Although some difficult decisions had to be made, the assessment did much to place the responsibilities and activities of each of our field centers in perspective as they relate to future proprams and to the size and composition of the institution we will need to perform these programs.

Because planning is the key to reducing the uncertainties of the future, a new management forum known as the NASA Council was established last summer to focus on the issues affecting NASA's future. A major function of the council will be the development of a continuing planning process involving headquarters and the centers. The finalization of this process should produce a comprehensive and viable draft five-year plan. This plan and its later versions will be used to address the major issues in all program areas and to place them in perspective within the overall agency mission.

I believe that these planning efforts will be effective in reducing many of the uncertainties we have faced in recent years. I also believe that these actions will provide us with a road-map that will assist NASA as well as the public it serves, to better perceive, understand and prepare for the opportunities that lie ahead.

Sincerely,

A. M. Lovelace

A. M. Lovelace

Planetary Rover Vehicle under Study

Many of the members of the Viking team, as well as independent observers of the Martian mission, are convinced that future unmanned explorations of planets may profit greatly through use of vehicles similar to the lunar roving vehicle used so effectively during Apollo missions to the Moon.

Against the possibility that such vehicles may be called into service in future planetary investigations, several conceptual studies are underway at aerospace companies and at various NASA facilities. These studies focus on lightweight and compact landing craft capable of roaming over extensive surface areas of planets.

One extremely promising study project, known as the Elastic Loop Mobility System (ELMS) is in progress at NASA's Marshall Space Flight Center. The principal element in the system is a mobile landing craft which employs a continuous elastic-loop track device (see illustration) that could be used in place of the landing pads on the "feet" of the Viking landers. The loop design allows for uniform and low-contact pressures as the vehicle roves over the ground, and it provides its own suspension system.

Testing has shown that the traction driven vehicle moves with great efficiency over both soft soil and rough terrain, and requires only a small amount of energy for a high-powered performance. It can climb steep slopes and negotiate valleys and crevasses. A recent analysis of the vehicle's capabilities by a team of space experts from industry and NASA led to the conclusion that the ELMS can be integrated with Viking lander hardware. Such a concept would provide a mobile laboratory capable of conducting unmanned scientific missions on the Martian surface for six months, along traverses ranging up to 150 kilometers or 90 miles. Theoretically, project analysts say, these estimates might be extended to two years over traverses of 500 km. (300 mi.)

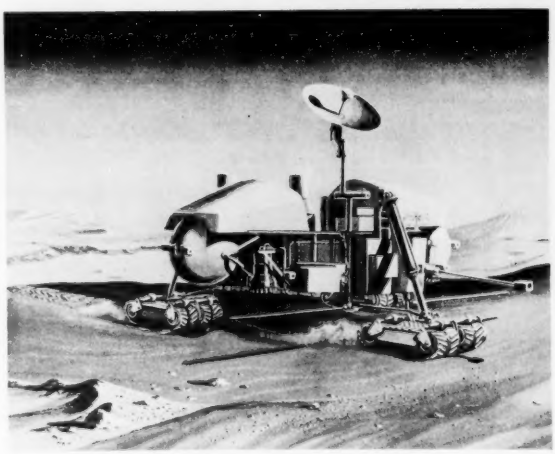
In summary, the ELMS reports seem almost to echo the scientific opinion expressed by individuals closely involved in the Viking mission to Mars. At a recent press conference held in Washington, D.C., for instance, space scientist Dr. Carl Sagan talked about the value of a roving vehicle on Mars, saying:

"My personal opinion, and this is not necessarily the view of NASA, although I dearly hope it is, the obvious follow-on to Viking, the device to take advantage of this extraordinary success [Viking] is an unmanned roving vehicle with some improved biological experiments, more reagents, more onboard logic, with a drill to get down to depths where there has been no ultraviolet light for a very long time—possibly with a microscope—but the key point is to be able to rove.

"Because then you could land in the safe places and wander to the exciting places, which are more likely to have biology or organic chemistry, the places which may have a much more exciting geology than the two relatively dull places we landed in.

"A rover could wander hundreds to thousands of kilometers in a nominal lifetime. It could wander to its own horizon every day. Anything you see today, you could examine close up tomorrow. You could have the capability of roaming over the polar ice . . . and running down one of those stream beds—of fully exploiting the marvelous heterogeneity of Mars."

Development of ELMS is sponsored by the advanced development office of NASA's Office of Space Science. It involves a team effort by the Lockheed Missiles and Space Company's Huntsville Engineering Research Center, the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Miss., and the Marshall center's Science and Engineering Directorate. The Langley Research Center's Viking Project office and the Martin-Marietta Corp. also are involved in study of the project. Technical direction of the research and development is the responsibility of Dr. Nicholas C. Costes of the Marshall center.



Planet Rover—The Elastic Loop Mobility System as an artist sees it. This adaptation of the lunar roving vehicles may one day travel over surfaces of planets millions of miles from Earth.

Viking Roving Vehicle—Dr. Nicholas C. Costes of the Marshall center points to a model of the Viking lander to show how the craft could be equipped with a mobility system to broaden exploration of the Martian surface. Behind Dr. Costes is a full-size model of the Elastic Loop Mobility System (ELMS), developed by a team of researchers under his direction. On the table is a three-unit ELMS model used to demonstrate its maneuverability over obstacles and on soft-soil slopes.

Aviation Early Warning System in Full Swing

The NASA Aviation Safety Reporting System received nearly 1,500 reports during its first three months of operation. (See NASA *Activities* for July 1976, for details about the ASRS.) Information contained in reports prompted the submission of 130 alert bulletins to the Federal Aviation Administration.

Reports received described occurrences in nearly every type of aviation operation including domestic and charter air transport, corporate and personal business flights, pleasure trips, flight training and military flying.

The reports dealt with air traffic control procedures, flight operations, pilot or controller workload, and hazards to ground personnel. Navigation and communication equipment problems were described. Some concerned equipment malfunctions while others described a need for reconfiguration or additions to equipment. Physical obstructions to air navigation were identified.

A substantial number of ASRS reports involved human error. Careful analyses by reporting personnel of why they erred suggest that many individuals have learned from their own experiences. Some of the reports will be useful instructional tools in education programs for future flyers, others have provided insights into system factors that contribute to human errors. NASA has described these factors in bulletins forwarded to FAA for investigation and action.

Pilots and aircrew members submitted 62 percent of the reports and air traffic control personnel accounted for 34 percent. Twelve reports concerning aircraft accidents were identified and forwarded to the National Transportation Safety Board and the FAA, as required. No reports contained information relating to a criminal offense. Most reporters' names were deleted, as specified in the FAA/NASA memorandum of agreement.

Phases of flight during which occurrences were observed and subsequently reported, based on percentage of reports received, included preflight and ground taxi (6 percent), takoff and climb (18 percent), cruise (22 percent), descent (16 percent), approach and landing (27 percent) and all flight phases (11 percent).

The NASA system is a part of the FAA Aviation Safety Reporting Program. The program enables the FAA to take positive action to increase the safety of the national aviation system.

The ASRS is designed as an early warning system. Reports describing programs are voluntarily submitted to NASA by pilots, air traffic controllers and others in the national aviation system.

The ASRS is receiving broad support within the aviation community. The quality of the reports has made it possible to gain an appreciation of the problems without extensive research, enabling ASRS to disseminate information about problems promptly and effectively. This is the primary aim of the program.

Speaking up for Women—Dr. Harriet Jenkins (second from left), assistant administrator for Equal Opportunity Programs at NASA headquarters in Washington, D.C., was guest speaker at a Marshall center-sponsored luncheon for women employees. It was the final event in a week-long program of activities. Greeting Dr. Jenkins on her arrival are (left to right) Jimmie Dew, Richard G. Smith, and Arthur Sanderson.

Vikings Test Einstein Theory

Scientists are using the Viking spacecraft on Mars to test Einstein's theory of general relativity in an experiment that may be 10 times more accurate than any previous test of the theory.

Both pairs of Viking orbiters and landers are used in the test, which involves the measurement of round-trip travel time of radio signals between Earth and the spacecraft. General relativity predicts that these signals will be slowed as they pass the Sun.

The tests are being conducted as Mars (as seen from Earth) passes directly behind the Sun. Radio signals take 42 minutes to travel from Earth to the spacecraft and back. The predicted relativistic slow-down of the signals reached a maximum on Nov. 25, causing an increase in the travel time of about two 10-thousands of a second. Because of the precise Viking radio communications system, the 42-minute round-trips of signals can be timed with an error of only one 10-millionth of a second.

Einstein's theory of general relativity is the fundamental theory of gravitation, one of the known four basic forces in nature. Although it is the weakest force, gravitation governs all large-scale motions of matter and radiation in the universe, and bears on the question: Will the universe continue to expand forever, or will it eventually reach a maximum size and collapse?

Gravitation also is a key element in understanding the formation and evolution of such diverse astrophysical objects as galaxies, black holes and neutron stars.

Despite its importance to astrophysics, general relativity has been subjected to the fewest tests of any fundamental theory. Laboratory experiments cannot accurately measure effects predicted by general relativity; experiments must encompass the solar system. The four Viking spacecraft are well suited to this test, both because they enable round-trip delays to be measured with great accuracy and because they can be used to determine other contributions to delays well enough to separate the relativistic contribution. Other contributions stem from two sources: the orbits of Earth and Mars, and the Sun's corona, through which radio signals must pass.

This type of test of Einstein's theory was first suggested in 1964 by Dr. Irwin Shapiro of the Massachusetts Institute of Technology, now a member of the Viking radio science investigation team. The first such tests used radar signals reflected from Venus and Mercury, and agreed with the theoretical predictions to within a five percent experimental error.

The Mariner 6 and 7 spacecraft enabled this limit to be reduced to three percent; Mariner 9 reduced the error to two percent. Other tests provided verification at the one percent level. The Viking experiment, if it reaches its potential of a 0.1 percent accuracy, would yield a 10-fold improvement over all past tests.

A special Viking Project group, headed by W. F. Cuddihy of NASA's Langley Research Center, which manages Viking, is coordinating all planning activities for the experiment. Ranging measurements are being directed by a special ranging team, headed by Tomas Komarek and assisted by Arthur Zygielbaum, both of NASA's Jet Propulsion Laboratory. Data analysis will be done by the radio science team, led by Dr. William H. Michael, Jr. of the Langley center. Responsibility for analysis rests with Dr. Shapiro and his colleagues, Drs. R. D. Reasenberg, R. B. Goldstein, and P. E. MacNeil of M.I.T., and Dan L. Cain and his colleagues, J. D. Anderson and M. Keesey of JPL.

Symposium Considers Life in Space

The von Karman auditorium at NASA's Jet Propulsion Laboratory recently was the scene of a student symposium entitled, "The Search for Life in Our Solar System." The program was a cooperative effort among the student programs division of the American Institute of Aeronautics and Astronautics (AIAA), the Forum for the Advancement of Students in Science and Technology (FASST), and the Public Educational Services of JPL, under Benito Casados.

The day-long program brought out more than 200 students and faculty, who represented 40 colleges and universities.

Noted science fiction writer, poet and playwright Ray Bradbury, approached the search for life in our solar system on a philosophical note, describing the space program as a "theater of history where you rehearse things years ahead of time." With poems dedicated to the space program, Bradbury captivated students with what he described as the importance of taking "our life force to other worlds," and "relating ourselves to the Universe."

Commenting on the pessimistic returns of Viking that indicate lack of life on Mars, Bradbury said that, "There *is* life on Mars and it is us! I don't care if we find a thing with our chemical machines and our experiments. We are there! Our brain is there! Our hand is there! Our heart is there! Our dream

forever is there! That's the important thing. Us on Mars and on out into space!" proclaimed the writer.

Continuing the program, a joint discussion by James Martin (former Viking project manager), Dr. Gerald Soffen and Alan Binder of the Viking project science team, gave the students an overview of the engineering development of the Viking Mars lander and its biological and geological investigations.

Martin indicated a need for follow-on Mars landings, utilizing a possible roving capability to "get us over the horizon." Development of a terminal hazard avoidance system with new couplings of television and computer technology may make future "high-risk" landings possible, said Martin.

Binder and Soffen described the relationship between geology and biology and defined the main point of the Viking mission to Mars not as "Is there life on Mars?," but if there *is* life on Mars, is it of the same origin as terrestrial life? According to Soffen, scientists are leery of proclaiming a life or no-life situation on Mars, simply because of the need to define the basic question: "What is life?" Using Earth-based biological and chemical answers may lead to the wrong conclusions, explained Soffen.

Dr. Jesse Moore, deputy manager of the flight projects planning office at JPL, described the future of unmanned probes in our solar system. Moore provided students with an overview of "futuristic" planning on unmanned probe research.

Scientist astronaut Dr. Karl Henize

Science-fiction writer Ray Bradbury

Future "manned" exploration of Mars was the subject of a presentation by Dr. Karl Henize, scientist/astronaut with the NASA Johnson Space Center. Henize developed a line of rationale on the value of manned exploration on Mars in contrast to use of robots, such as the Viking lander. He indicated that, although the technology is available, politically and economically the need for human exploration of the planet may not be realized until the 1990s or early 2000s.

During the day, students participated in an extensive tour of the JPL facilities, including a robotics demonstration, a view of the Viking Control Center and observation of Mariner/Jupiter/Saturn hardware preparation.

A special dinner presentation by Dr. John Billingham, chief, program office for the search for extraterrestrial intelligence (SETI) at NASA's Ames Research Center, took the students out of the solar system to the far reaches of the Universe, in search of intelligent life and other civilizations. Billingham presented information on the current Ames study on use of large radio arrays for an Earth-based, space-based, or Moon-based search for extra-terrestrial civilizations. A follow-up to Billingham's discussion will take place at a special symposium for interested students to be held at the Ames Research Center this coming February on the Ames/SETI program.

Roberson Chosen as Sloan Fellow

Floyd I. Roberson of NASA headquarters, a 1976-77 selection for the Stanford University's Sloan Executive Fellowship program, joins fellow NASA colleagues Lado Muhlstein, Jr. (Ames Research Center) and JoAnn Morgan (Kennedy Space Center) for a one-year stay at the California university. Previously Roberson was deputy director of Solar Terrestrial Programs in the Office of Space Science.

Forty-two executives, aged 30 to 45, are enrolled in this year's special course of study offered at Stanford's Graduate School of Business. They come from the United States (eight states and the District of Columbia) and 12 foreign countries.

To be eligible, applicants must be nominated by their employers and must meet regular admission requirements of the business school. The application for admission must include a satisfactory score on the admissions test, records of previous college work, a minimum of eight years of successful work experience, three professional recommendations and a guarantee that the employer will pay all costs of the program.

The executives take business management courses such as accounting, economic analysis, finance, marketing and organizational behavior, supplemented by seminars with top corporate executives. Rounding out the schedule are lectures in humanities subjects given by professors from other schools and departments in the university.

New Space Flight Deputy

Glynn S. Lunney recently was appointed deputy associate administrator for NASA's Office of Space Flight. He replaces Dr. William C. Schneider, now assigned to the Goddard Space Flight Center as director of Project Management. Lunney will fill his new post until Schneider's Goddard assignment is completed.

Previously, Lunney served as manager of the shuttle payload integration and development program office at the Johnson Space Center.

Lunney, a native Pennsylvanian, holds a B.S. degree in aeronautical engineering from the University of Detroit. He joined NASA at the Lewis Research Center in 1958, later transferring to the Langley center, and then to Houston. From 1964 to 1968, Lunney was chief of the flight dynamics branch as well as a prime flight director during the Gemini program. He continued working as a flight director throughout the Apollo program and in 1972 was named manager of the Apollo spacecraft program and technical director of the Apollo Soyuz Test Project.

Lunney has won many awards, including the NASA Distinguished Medal, the NASA Exceptional Service Medal, the Lawrence Sperry Award and the Arthur S. Flemming Award.

Stratospheric Water Vapor

Another piece of the global jigsaw puzzle concerning climate and ozone has slipped into place as a result of a series of aircraft flights that probed the skies at altitudes as high as 18,000 meters (60,000 feet or more than 11 miles) ranging over Alaska to Argentina, January to May, 1974.

Conducting the experiment for the Department of Transportation's Climate Impact Assessment program was Ernest Hilsenrath of NASA's Goddard Space Flight Center. He presented his findings at the American Geophysical Union meeting in San Francisco on Dec. 8, claiming in his scientific paper that for the first time water vapor has been mapped in northern and southern latitudes in the lower stratosphere.

What it means, he says, is that we now have information on the transport and distribution of water vapor from tropical areas to the higher latitudes, as well as vertically to the stratosphere. Such knowledge is important to the understanding of the Earth's ozone layer and possibly its climate. Ozone transport and distribution from lower to higher latitudes are believed to function in much the same manner as water vapor does.

Previous studies of water vapor in the stratosphere have been limited to short flights by aircraft or balloons which returned no data on latitudinal transport. Hilsenrath points out, however, that the 1974 flights at higher altitudes confirm results of numerous balloon flights over a 10-year period before 1974, in which findings showed increasing amounts of water vapor in the stratosphere.

In addition, the 1974 aircraft data show that the tropic regions provide most of the water transported to higher latitudes. Ozone also seems to be a product of tropic areas and is believed moved to the higher latitudes, north and south, perhaps by mechanisms similar to those that transport water vapor, thus causing the highest ozone concentrations to occur in the higher latitudes.

The amount and distribution of water vapor and ozone in the stratosphere have an important impact on the Earth's climate since those quantities may indicate a change in Earth temperatures. The amount of water vapor and ozone at upper altitudes is believed to have a direct relation to whether the Earth is warming or cooling.

In addition, inasmuch as ozone acts as a buffer to protect the Earth from over-exposure to harmful ultraviolet rays from the Sun, the more ozone in the stratosphere—within certain bounds—the better for life on Earth.

The experiments, flown on an Air Force RB-57, were managed by Goddard under contract to the Department of Transportation.

Much Lighter than Air—Otha Vaughn, Jr. a Marshall center scientist, monitors the performance of experimental cloud physics hardware during a period of weightlessness aboard the NASA-JSC gravity test aircraft. The hardware may be flown aboard the Spacelab as part of the atmospheric cloud physics laboratory.

Testing in Zero Gravity

Prototypes of experimental cloud physics hardware, possibly to be flown aboard the Space Shuttle/ Spacelab as part of the program of the atmospheric cloud physics laboratory, are now under development at the Marshall center. O. H. Vaughn of the aerospace environment division of the center's Space Sciences Laboratory has completed a series of flight tests of the hardware in a weightless environment.

The necessary weightlessness is achieved during a series of parabolas being flown by the Johnson Space Center's zero gravity test aircraft (KX-135). During periods of weightlessness, up to 25 seconds per parabola, Vaughn monitors the performance of the hardware. Later, data on the performance of each piece are analyzed to identify and correct any problems in the design concepts, performance and the man-experiment relationships. A total of 25 to 30 parabolas usually are flown during each test flight.

A weightless environment provides a longer observation period of the particles than can be obtained in similar periods by Earthbound facilities. In the latter category, objects under study usually must be supported by such devices as wires, spider webs, blasts of air, or electrical fields. The weightless testing is superior because it eliminates any contamination by the support method.

Researchers of atmospheric cloud physics believe the data they will receive during the 1980s from experiments performed in the Spacelab will help them toward a better understanding of the micro-physical process taking place in the atmosphere. Through the application of the knowledge acquired in their experiments to Earth problems, the scientists hope to develop techniques to accurately predict, alter and control the weather—for instance, increase snowfall and rain, dissipate fogs and suppress lightning—for the betterment of humanity and Earth's environment.

Minority Business Contracts Increase

Johnson Space Center's support of minority business enterprise represents a significant aspect of the total equal opportunity effort. In fiscal year 1976, impressive gains were made in the dollar volume of minority business contracting. During the period, a total of $2,265,727 was placed under the SBA Business Development Program for disadvantaged persons. This total exceeded the center's goal of $2.2 million and raised its total number of awards to almost $6.8 million since the program began.

The minority company receiving the largest total awards this fiscal year was Chimex-Systems, Inc., a Houston-based electronics firm. One of the contracts, valued at $439,206, is for engineering support services for the experiment systems division. Another, valued at $452,000, is for keypunch, data entry, and verification in support of the earth resources and space shuttle programs.

Other contractors receiving awards of over $100,000 were Data Transportation Corporation of New York City; Pride & Power-Speedy Maintenance Service and Supply, Caspan Corporation, Jefferson Associates, Inc., Triple H Construction Co., Inc., and Site Work & Concrete Contractors, all of Houston.

The thrust of the Minority Business Enterprise Program in recent years significantly shifted toward the technical and engineering areas. Of the total number of awards to minority firms, 63 percent were contracts for computer programming, cataloging and indexing, and engineering services. The program originally was concentrated in the crafts and construction areas. Major emphasis is placed on providing technical and management assistance to minority firms during precontract, contract performance, and post contract situations.

Recognition by Minority Businessmen—Plaque to the Johnson Space Center and Small Business Administration (SBA) is presented to Dr. Christopher Kraft, center director and to Limas Jefferson and John Carey for the SBA. The plaques were presented by the contractors and businessmen for excellent participation by JSC and SBA in the business development program. From left to right are: Ronald B. Wilson, SBA assistant district director for procurement assistance; Jose R. Perez, JSC minority business enterprise specialist; Limas Jefferson, president, Jefferson Associates, Inc.; Kraft; John Carey, SBA district director; Frank C. Urteaga, president, Caspan Corporation; and James J. Neal, JSC director of procurement.

Johnston

Colom

Wallops Celebrates Today's Woman—The second annual Federal Women's Day was marked at the Wallops Flight Center by a program that featured single-act playlets entitled "Two Centuries of American Women on Parade," guest speakers, and a luncheon. Keynote speaker was Dr. Mary Helen Johnston, an outstanding metallurgical engineer stationed at the Marshall center. Also featured was Audrey Rowe Colom, the first director of women's activities at the Corporation of Public Broadcasting in Washington, D.C. She gained national attention as the president of the National Women's Political Caucus and as a Presidential appointee to the National Commission on the Observance of International Women's Year.

Argentina to Build Landsat Ground Station

Argentina plans to build Latin America's second ground station designed to receive Earth resources data directly from NASA's Landsat satellites under a recently concluded agreement between NASA and the Argentine space agency, Comision Nacional de Investigaciones Espaciales (CNIE).

The new ground station, to be built by CNIE at Mar Chiquita on the coast south of Buenos Aires, will be capable of receiving, processing and disseminating data covering all of Argentina and all or parts of Chile, Bolivia, Brazil, Uruguay and Paraguay.

The operation of the Argentine station in tandem with Latin America's first ground station located in Brazil, will assure continuous coverage on a regular basis of almost all of the South American continent.

Under the memorandum of understanding covering NASA's open data dissemination policy, CNIE will make copies of Landsat information available to anyone requesting such data from South American regions. The agreement is contingent upon the development of a procedure through which Argentine and Brazilian agencies will provide data on areas covered by both stations. Discussions begun in November were expected to result in prompt resolution of germane questions.

After the first six months of operation of the Mar Chiquita station, CNIE will provide NASA with $200,000 annually to share in the cost of operating the Landsat satellites.

Under the NASA-CNIE agreement, construction of the Argentine ground station must be underway within 15 months, and should be completed within two to three years. Ground stations presently are in operation outside the U.S. at Prince Albert, Canada; Cuiaba, Brazil; and Fucino, Italy. Iran, Chile and Zaire have signed agreements to build their own Landsat stations, and Canada has nearly completed a second Landsat station near St. Johns, Newfoundland.

U.S. ground stations for Landsat are located at Fairbanks, Alas., Goldstone, Calif.; and at NASA's Goddard Space Flight Center.

Landsat-1, launched in July 1972, is able to return data while within range of ground stations, but tape recorders aboard the spacecraft are no longer operable. An identical satellite, Landsat-2, was launched Jan. 22, 1975, and is now returning data from around the world, though only one of its two tape recorders is still operating. Landsat-C currently is scheduled for launch in late 1977.

NASA has provided Earth resources satellite data to several hundred scientists in the U.S. and to more than 50 foreign countries in a program designed to demonstrate the satellite's usefulness. Data have been purchased from the Department of Interior's Earth Resources Observation Systems (EROS) Data Center in Sioux Falls, S.D., by scientists in more than 125 countries.

More than 120,000 separate views of the Earth from NASA's Landsats have been provided to the EROS Data Center, where independent scientists and the general public may obtain material for a nominal fee.

Viking Pioneer Leaves NASA

James S. Martin, Jr., Viking Project manager since late 1968, resigned from his NASA post last Nov. 15, to become a vice president of Viking's prime contractor, the Martin Marietta Aerospace Company at Bethesda, Md. The date marks the official end of Viking's primary mission. Martin was succeeded at Viking's operational headquarters at JPL in Pasadena by mission director G. Calvin Broome. Broome will serve as both project manager and mission director during the final 18 months set for Viking's extended mission, which will remain based at JPL.

In his eight years with the Viking project, based at the Langley Research Center, Martin led a nationwide team of NASA, industry and university engineers, scientists and technicians in developing and operating the mission to Mars. His Viking responsibilities took in Langley, JPL, Martin Marietta Aerospace's Denver division, and subcontractor plants and universities throughout the country. During the past two years, he

managed Viking launch preparations from NASA's Kennedy center and led the 750-person Viking flight team at JPL. His face became familiar to television viewers as he explained to the world the events that took place as the Viking spacecraft sped toward the Red Planet, and answered the President's queries during the dramatic flight last July.

Martin came to Langley in 1964 as assistant project manager of the lunar orbiter project, a photo reconnaissance mission. It placed five spacecraft in orbit about the Moon to map its surface and help scientists select landing sites for the Apollo program's surface exploration missions.

Previously he was employed at the Republic Aviation Corp., as assistant chief technical engineer, chief research engineer, and manager of space systems requirements. Martin has won several awards for NASA work, including a 1967 Exceptional Service Medal for his lunar orbiter management, and the Air Force Association's von Karman Award last year for his and his team's work in the exploration of Mars.

Born in Washington, D.C., Martin grew up in Springfield, Ill. He received a bachelor of science degree in aeronautical engineering from the University of Michigan in 1942 and completed the Harvard Graduate School of business middle management program in 1957.

Langley's director Donald P. Hearth gave credit to Martin for the success of Viking, calling the mission an outstanding triumph of engineering and science. "Jim's innovations, his dedication, and his driving leadership have been largely responsible for the great success of Viking. We at Langley will very much miss Jim and his leadership, and I know that all of NASA will feel the loss of his management abilities," Hearth said in announcing Martin's plan to return to private industry.

New Publication on Solar System

A scientific study entitled "Evolution of the Solar System" recently was published by NASA's Scientific and Technical Information office. The authors are two internationally known scientists who, in this new work, deal with the origin and evolution of the solar system from an approach that integrates chemistry and physics.

The 559-page volume, by Dr. Hannes Alfven and Dr. Gustav Arrhenius, traces the early history of the solar system and its evolution, and describes its present-day characteristics. Both men are professors at the University of San Diego. Alfven is a Nobel Laureate in plasma physics; Arrhenius is an oceanographer and Earth scientist. They say that their purpose in writing the book is "to make the physics understandable to chemists and the chemistry understandable to physicists."

The book is aimed primarily at upper-level physical-science majors or graduates, and working scientists in Earth or space sciences who desire a broader perspective of their fields. But other less specialized readers may find new and challenging insights into the subjects covered.

The book is divided into six sections: Present State and Basic Laws; Accretion of Celestial Bodies; Plasmas and Condensation; Physical and Chemical Structure of the Solar System; and Special Problems. The last-named chapter deals with the evolution of the Earth-Moon system, the early Sun, and the origin of the Earth's oceans and atmosphere. Cross-referencing and a comprehensive index permit readers to study each section independent of the others.

The publication, NASA SP-345, may be purchased for $11 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The GPO stock number is 003-000-06613-6.

Former NASA Student Employee Now a Principal Investigator

A former student research assistant at the Marshall center, now a member of the faculty at Alabama A&M University in Huntsville, has been designated the principal investigator of a study for the center.

Dr. Oscar Montgomery and other researchers at the Huntsville school will develop remote sensing applications for resources study and management under a $35,000 grant from NASA and MSFC. The grant, under the Minority Institutions Research Program, is for continuation of a study sponsored at Alabama A&M over a period of several years.

A major part of the research effort will be to study and catalog the transportation network of Alabama, including highways, railroads, water systems and airports. The researchers also will devise a system by which information can be stored in quick retrievable form and readily can be updated.

Montgomery worked as a student research assistant at the outset of the continuing study, graduated from A&M, and received a Ph.D. from Purdue.

Buggy Study

NASA literally is trying to work the bugs out of aircraft, flying a transport plane equipped with a modified wing to study various materials and methods that will prevent colliding insects from sticking to the leading edge of aircraft wings.

The program is being conducted by NASA's Langley Research Center and Dryden Flight Research Center in California. The effort is part of the NASA aircraft energy efficiency program, aimed at developing a 1985 transport with a potential 20- to 40-percent fuel saving.

Studies have shown that impacted insects sticking to the leading edge of the wing can cause air flow to become turbulent. This cancels the fuel savings made possible by laminar flow control.

Drag reduction by laminar flow control is one of the most promising technological developments toward achieving impressive fuel savings. The concept involves removing the surface air boundary layer by suction to maintain laminar, or non-turbulent, air flow.

Two teflon-coated panels, two panels with a coating similar to that on aircraft windshields and one bare aluminum panel, all approximately 46 centimeters (18 inches) wide, have been installed on the leading edge of the test aircraft. Instrumentation probes also have been installed above the panels. These probes will be used to determine whether there is a change in the air flow (from laminar to turbulent) caused by insects adhering to the panels. Because of the different coatings on the five panels, the number of insects sticking to the leading edge and the resultant air flow should vary from panel to panel.

On the lower surface of the leading edge, washer nozzles for a pressurized water system have been located at four-inch intervals. On certain flights, the water system is activated to determine the effect of flushing off the insects.

On a typical flight, the aircraft flies low over alfalfa fields and sewage ponds, where large numbers of flying insects strike against the plane. The aircraft then lands and quantities of insects adhering to the various panels are documented. The aircraft then takes off and climbs to a high altitude, cruising at high speed to allow for measurement of the insects on the air flow.

Chemistry Expert Assigned to Headquarters

A recent addition to NASA's Washington headquarters is Patricia O'Donnell, a research scientist from the Lewis Research Center. She will spend a year in the Office of Energy Programs, solar energy division, where she is called upon to provide technical and management support in the area of energy storage.

O'Donnell joined NASA's Lewis center in 1954. Her specialty was in fluorine chemistry until recently when she was put in charge of fundamental studies in the Redox Energy Storage Systems office at the center.

A native of Cleveland, O'Donnell received her bachelor of science and master of science degrees at Case Western Reserve University (Cleveland) and was elected to Iota Sigma Pi, a national chemical honor society.

She is the author of some 30 technical papers, and the recipient of an invention award for a patent concerned with the stress corrosion cracking of beryllium. Last year, O'Donnell received an "Outstanding Woman at Lewis" award. In past years, she was an invited lecturer at the Gordon Research Conferences (held each year in the eastern U.S., at different locations); the Institute of Mining in Krakow, Poland; and the University of Kyoto, Japan.

O'Donnell says she is well pleased to be chosen for participation in NASA's Career Development Program and expects to advance her knowledge considerably during the Washington stint. She adds that she and her three children are enjoying Washington greatly and finding the city exciting and attractive.

Prospectus

Earth Resources Technology Satellites

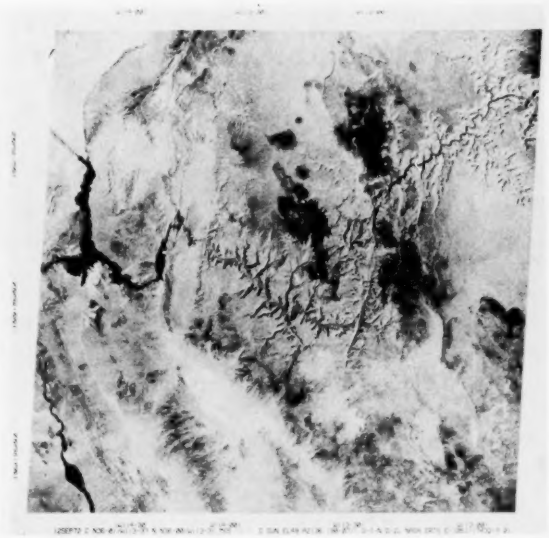
Early *homo sapiens* subsisted just as his simian neighbors did. Families ate berries, plants and other wild vegetation. But when they learned to fashion weapons, hunting began. As eons passed, the weapons evolved into tools and utensils and people learned to cultivate the soil. Thus, humans became not only predators but producers. Down through the centuries, most of society was agrarian—in Europe, Asia and primitive America. Only with the advent of the Industrial Revolution did a large number of people leave their farms and become artisans and workers in large cities. One principal reason for the urban influx was the very uncertainty of agriculture. In most parts of the world, it has traditionally been something of a gamble, subject to the impact of natural disasters or human mismanagement. There have been times of drought and starvation, ruinous floods such as the rising Yangtze river, massive grain failures in Asia and Russia, and our own "Dust Bowl" of the Depression years. Just two years ago, a great drought occurred in the sub-Saharan region of the Sahel. All people of good will were moved by the pathetic pictures of the Sahel's children, with their staring eyes and distended bellies. Even in this highly technological, contemporary world, nature cannot be denied. Yet, through almost two decades of reaching into space, we have developed the potential instruments of hope. Hunger may never be eradicated but space science has the means to mitigate and control many of the ravages that afflict the Earth.

Jacques Cousteau, whose element is the deep sea, gave his critique of progress during a recent forum at NASA's Langley Research Center. Captain Cousteau said, "When man explores for resources, his motivations are clear. They are what we call, superficially, logic." The national space agency, in keeping with that view, has embraced the concept that distant exploration could also logically be turned back and used as Earth exploration. For agriculture, the first answer is Landsat.

In this century, with the coming of powered flight, we learned to gather information on crops by the technique of remote sensing—the acquisition of knowledge about topography and terrain from a distance. But aircraft are limited in that pursuit because they must return to the ground. Also, planes can be expensive to operate or relatively slow when used for data acquisition, and varying light conditions can pose problems. With spacecraft, we can repeatedly fly over and observe an area, any area, without additional cost or impediments.

On July 23, 1972, with little fanfare, NASA launched the first earth resources space vehicle. Initially called ERTS, for Earth Resources Technology Satellite, it was renamed Landsat. Its expected working life was one year. Its purpose was to photograph and measure the resources of this small globe in the planetary system.

Today, more than four years later, the first Landsat is still operating efficiently, though its tape recorders no longer operate, and it has been joined by a twin satellite. Each makes a complete orbit of the Earth every 103 minutes, or 14 orbits a day. Both satellites are therefore scanning the planet every 18 days. They record the unique signatures radiated by crops and the land on which they grow. They find water and minerals and even register the impact of man-made structures. Landsat pictures have motivated geologists to find oil and mineral deposits in the Rocky Mountains, Oklahoma, Alaska and the jungles of Brazil. This year,



Looking Down at the Grand Canyon—A color composite photo—here in black-and-white—taken by Landsat from an altitude of 914 kilometers reveals crops, trees, plants, suburbs, cities and barren land. Some visible geographical landmarks are the Grand Canyon in the meandering feature at center; Lake Mead and Lake Mohave at center left; and the Colorado River running through center to upper right.

U.S., Israeli and Egyptian scientists concluded from Landsat evidence that great amounts of water may be under the arid Sinai Peninsula, enough water to turn the desert green.

From space, the two Landsats report the breakup of ice in lakes and navigable waters and even help fishermen locate heavy schools of fish. A farmer or cattle and sheep ranchers also can learn a great deal from Landsat. On the ranges of the American West, the summer depletion of available surface water caused by an animal consumption and seepage is photo interpreted. Shrub fires are averted. In the winter, snow cover is assessed and periods designated when a range can be grazed without damage to forage plants.

The flow of information from higher than 500 nautical miles goes to three stations in the United States: NASA's Goddard Space Flight Center, Greenbelt, Md.; Goldstone, Calif.; and Fairbanks, Alas. In the vicinity of the nation's capital (Greenbelt), the stream of pictures and numbers is recorded on film and magnetic tape by high-speed computers. The data are then given to a recently established division of the department of the Interior at Sioux Falls, S.D., and to other agencies; they are readily available to any farmer or rancher. NASA and the Bureau of Land Management (Interior) also are starting a project to gain an inventory of land on which a wild vegetation resource may occur. The program will be managed out of Denver. Eventually, the facts and figures will be fed to the U.S. Department of Agriculture, state agriculture departments, the agencies for state resources, and finally will sift down to county extension services.

In the technical sense, Landsat is still in the research and development stage but it has already done work of great value. The two satellites will be joined by a third, and the three will play an important role in a cooperative project involving NASA, the USDA and NOAA (of the Department of Commerce), called the Large Area Crop Inventory Experiment, or LACIE. This innovation will combine Landsat imagery with that from the world meteorological network and weather satellites to provide valuable information to people and organizations managing crop production and distribution. The first test is on wheat growth and the testing ground is North America. Based upon results to date, the experiment is being extended to other lands and eventually to other crops. The potential benefit for all the world is enormous. ■ ■ ■

Air Turbulence Predicted in Radiation Study Spinoff

Radiation tests conducted aboard a NASA flying laboratory have led to the unexpected discovery of a possible explanation of the causes of air turbulence. Conducting the studies, designed to pinpoint for NASA scientists the sources of radiation they were investigating, was Dr. Peter M. Kuhn, a scientist with the National Oceanic and Atmospheric Administration. He claims that the key to turbulence is water vapor.

Kuhn, a member of NOAA's Environmental Research Laboratories (at Boulder, Colo.) believes that techniques developed following his NASA study may allow for at least 12 minutes warning to a pilot of air turbulence in the path of an aircraft.

In his investigation for NASA of how much of the radiation under study was from astronomical objects and how much from the Earth's atmosphere, Kuhn used an infrared radiometer aboard NASA's C-141 Gerard P. Kuiper aircraft to predict turbulence. His predictions showed a reliability factor of 81 percent.

Clear air turbulence is thought to result from wave motions in the atmosphere, in shape much like waves that break on the seashore. By experimenting with different infrared wavelengths, Kuhn has been able to detect the breaking waves more than 100 kilometers (60 miles) ahead of the plane.

He noticed that sudden, drastic changes in the amount of water vapor often were followed within a few minutes by turbulence. To see if these fluctuations might be a reliable indicator of turbulence, he compared his water vapor readings with those from an instrument that had been installed on the plane to make accurate measurements of turbulence, and found a relationship.

Since then, Kuhn has continued his investigation, with the radiometer installed in the plane's main wheel well, looking ahead at an angle of between 7.5 and 15 degrees above the horizontal.

In 45 encounters with clear air turbulence, the radiometer provided advance warning of from four to 12 minutes in 41 cases, and gave only six false alarms. Kuhn thinks that ultimately it may be possible to predict the severity of the turbulence.

He believes the water vapor anomalies are caused by the wave motions of turbulence, which thin the water vapor in one place and concentrate it elsewhere. The concentration of water vapor at the altitudes where the research aircraft normally cruises—more than 12,000 meters (40,000 feet)—is fairly constant. The turbulent wave motions shatter this placid picture, producing alternating dry and wet areas.

The atmospheric waves that cause turbulence, Kuhn explains, can be set up in two ways. In the first, winds flowing over a mountain range may set up a standing wave above or in the lee of the mountains. Such lee waves cause frequent turbulence above the Rocky Mountains and occasionally severe windstorms along the eastern slope of the range.

The other atmospheric condition creating such waves is strong vertical wind shear—a sudden shift in wind speed or direction with height. The friction between two adjacent streams of air causes turbulence.

Highest Honor Accorded Dryden Engineer

Dr. Kenneth W. Iliff of the Dryden Flight Research Center recently became the first employee in the center's history to receive NASA's Exceptional Scientific Achievement Award. He received his medal at the annual NASA Awards Ceremony held in Washington, D.C. The certificate accompanying Iliff's medal read: "in recognition of his exceptional contribution to the field of aircraft flight test evaluation through the development of maximum likelihood estimator methods for parameter identification."

The 35-year-old aerospace technologist in 1973 was chosen as NASA's Outstanding Handicapped Federal Employee of the Year. Though a victim of bulbar and paralytic polio as a youngster and permanently confined to a wheelchair, Iliff continually has been active in his profession and in community affairs. His work with extremely experimental aircraft has led to numerous requests to address national and international conferences worldwide.

A native Iowan, Iliff earned his B.S. degrees in mathematics and aeronautical engineering from Iowa State University; he received his Master's degree from the University of Southern California and his Ph.D. in mathematical theory of systems from the University of California in Los Angeles.

Personnel Changes at Headquarters

Lunar and Planetary Programs acquired a new director in December, when Robert S. Kraemer was succeeded by A. Thomas Young. Kraemer went to the Goddard Space Flight Center as special assistant to GSFC director Dr. Robert S. Cooper. Young transferred from the Viking Project, where he served as Viking mission director and Viking deputy project manager.

Kraemer spent nine years at headquarters, nearly six of which were as chief of Lunar and Planetary Programs. At Goddard he will concentrate on center missions related to applications projects.

Young, before he joined the Viking project, was lunar orbiter definition manager at the Langley Research Center. As such, he was responsible for the development of mission objectives and requirements for Mars mission studies in Langley's advanced space projects office.

Culbertson to Presidential Committee

Philip E. Culbertson, Assistant Administrator for Planning and Program Integration, recently was detailed to temporary duty as Executive Director of the President's Committee on Science and Technology, a committee of Presidentially appointed experts charged with the responsibility of coordinating a broad inquiry into the present state of Federally sponsored research and development.

In his new post, Culbertson will manage the efforts of the committee staff in support of the study. The product of the committee's evaluation will be a set of recommendations to the President on the effectiveness of the Federal research and development establishment and the ways by which its effectiveness might be increased.

For the term of the detail, Thomas W. Chappelle, director of planning and program analysis, will be responsible for the coordination of all activities of planning and program integration.

Nostalgic Event

The first reunion of former members of the National Advisory Committee for Aeronautics was held at Asheville, N.C., last October. Abe Leiss of the Langley Research Center contributed the following account.

Why did over 600 NACA's converge on Asheville for their first reunion? The answer was obvious during the reunion weekend: The same morale that prevailed in yesteryear exists today among the remaining NACA's. Dedication to the job, love of fellow employees, pride in one's work and outstanding results have never been forgotten.

They came from many states, the District of Columbia, and Australia. Virginia led in the head count with 198, Ohio had 124, Maryland 70, California and North Carolina 19 each, Pennsylvania 24, Texas 22, Tennessee 21, D.C. 15, Alabama 11, and Florida 49. Montana, Kansas, Vermont, Hawaii, Illinois, Arkansas, Arizona, Minnesota, Michigan, Massachusetts, Kentucky, Louisiana also were represented.

The reunion was an outstanding success. Planning and organization was almost perfect and a good time was had by all. Everyone left with expectations of another get-together soon.

The loudest applause was for Jo Dibella, former secretary to Dr. Hugh Dryden. She initiated the gathering and was chairman of the reunion committee. She spent almost two years of effort to make the reunion a real success.

Master of ceremonies Ralph Cushman said he could not recognize any particular distinguished attendee, since *anyone* with the NACA label is distinguished!

Attendees included Mrs. Hugh L. Dryden, Mrs. Floyd Thompson, the Abe Silversteins, the Ira Abbotts, the John E. Dubergs, the Bruce T. Lundins, the Charles J. Donlans, the Francis Smiths, the Melvin Goughs, the Barry Graves, the T. Melvin Butlers, the Walter C. Williams, Mrs. Edward Sharp, Mrs. Henry Senasack (Dr. Lewis' daughter), Mrs. E. C. Draley, the Coleman Donaldsons, Mrs. Antonio Ferri, the Harry Fingers, the Paul G. Demblings, and the Clotaire Woods. Mr. and Mrs. Willson Hunter from Australia also were present.

Joe Shortal and John Collins repeated a song act that they performed in 1930 at a NACA get-together at Langley. Percy Keffer had the most tenure with NACA—38 years—of any in attendance. Between them, Mr. and Mrs. George Lumpkin from Hampton, Va., had 47 years service with NACA.

Marvin Forrest from Langley gave an excellent invocation. Ralph Cushman, Special Programs Coordinator at Headquarters, reminded us that the whole era of aeronautics started with Orville and Wilbur Wright in the same state—North Carolina—in 1903. In 1915, Congress created the NACA to solve the problems of air flight. In 1958, the Congress apparently decided that, having solved the problems of aerodynamics, NACA would be dissolved and NASA formed. He noted, however, that the problems of flight are still being vigorously pursued by NASA in many of the former NACA facilities.

NACA Alumnas—Ralph Cushman presenting reunion chairman Jo Dibella with "NACA Wings" plaque in appreciation for her outstanding work. Cushman was NACA's procurement and supply officer in 1958.

Ira Abbott recited the names of many of the past NACA shakers and movers who no longer are with us and proposed a toast to "good old times"; Charles Donlan compared the NACA attendance to that of the old time Yankee baseball team games; Dr. Duberg recalled that at NACA you didn't have to do much to stimulate people to act, as one could see by the reunion attendance; Bruce Lundin started the reminiscent anecdotes and story-telling; telegrams from Jimmy Doolittle (a former chairman of NACA) and Dr. George Low (who was being inaugurated as President of Rensselaer Polytechnic Institute the same week) were only a few of the many received.

The food was good, the atmosphere exceedingly friendly, the weather could have been better, but an exceptionally good time was had by all.

Did You Know?

Four hundred applications had been received for civilian astronaut pilot and mission specialist candidate positions, as of November 15. The Astronaut Candidate Program Office at the Johnson Space Center, which handles applications, reported that 8,238 applications and announcements had been mailed out in response to requests. Of that total, 179 went to JSC employees. The ACPO points out that civilian applications must be postmarked no later than June 30, 1977.

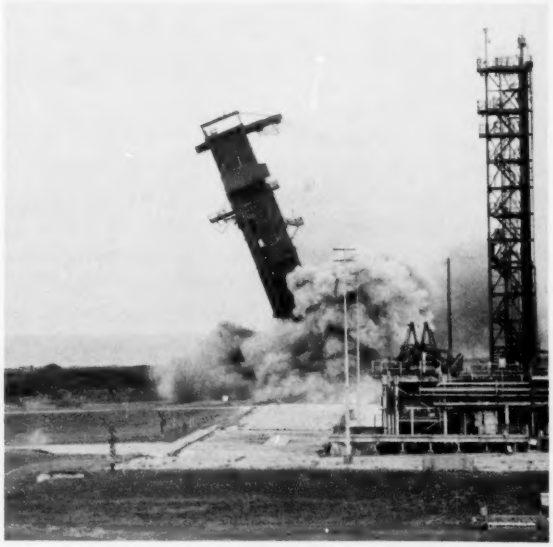
The Redstone test stand at the Marshall center has joined launch complex 39 at KSC as a historic site listed in the National Register of Historic Places. Before being phased out of active service in 1961, the stand made 364 test firings. On Oct. 2, during a special ceremony, members of the Alabama Historical Commission presented a certificate of registration to the center.

An updated "Astronauts Fact Sheet" is available at NASA headquarters (News Release No. 76-168). The publication contains biographical details and other information concerning the 73 astronauts who took part in NASA programs from April 1959 to the present.

A NASA tour patron recently purchased the millionth ticket for the 1976 season at the Kennedy Space Center, marking the seventh year that the million patronage mark has been passed since the tours originated in July 1966. By the close of 1976, more than 10 million people had taken escorted bus tours of the Kennedy Spaceport and adjacent Cape Canaveral Air Force Station.

The publication "Minority Profiles" is available at NASA headquarters. The full-color, 65-page booklet contains pictures and profiles of many of the NASA employees who are from minority groups.

Historic launch complexes 12 and 14 at Cape Canaveral were destroyed by explosive charges set by the Air Force on Nov. 30 and Dec. 1. The Atlas missiles used in the early days of the space program were launched from the two complexes, as were Mercury and Gemini flights. The first launch from complex 12 took place on Jan. 10, 1958, and 36 launches followed, the last on Nov. 5, 1967; the first Atlas ICBM was launched from complex 14 on June 11, 1957, followed by 31 more flights, the last one on Nov. 11, 1966. Now the facilities are too small to accommodate today's space vehicles and too costly to preserve as historic sites.



Deathblow to a Space Landmark—The first picture shows the beginning of the end of Launch Complex 14 at Cape Canaveral as a team of demolition experts dismantled it with explosive charges. The famous complex was a common sight to millions during the early days of the American space effort. The second photo was taken as the steel service structure fell to earth.

Personnel from NASA headquarters and from three NASA field centers took part in the final stage of the Spacelab preliminary design review, conducted by the European Space Agency in Noordwikj, the Netherlands, in late November. The purpose of the review was to be sure that basic design requirements have been met before the laboratory engineering model of Spacelab is built.

A new publication entitled "What's New on the Moon?" has been produced at NASA headquarters. The author is Dr. Bevan M. French, program chief, NASA Extraterrestrial Materials Research Program. A geologist, French has studied lunar samples and terrestrial meteorite craters for more than 10 years. The booklet, replete wtih dramatic photographs and diagrams, reviews the events that led to Moon landings and delineates many of the findings that resulted from Apollo missions to the Moon. ■■■■

Contractor News

The Norflor Construction Corp. of Orlando, Fla., has been awarded a construction contract by the Kennedy Space Center. Worth $284,900, the contract calls for the installation of an airlock in NASA's spin test facility at the Cape Canaveral Air Force Station to provide a clean-room environment for the prelaunch preparation of spacecraft. The installation will include a five-ton bridge crane; air conditioning; high efficiency particle accumulator; roll-up door; personnel airlock; and lines for electricity, vacuum, compressed air and gaseous nitrogen. The new clean room will be the site of preparation of future Delta-launched spacecraft and for Space Shuttle payload processing.

General Dynamics Corp., Convair Division, San Diego, has won a $73.6 million contract to build eight Atlas/Centaur launch vehicles. Awarding the four-year contract was NASA's Lewis Research Center, which provides management of Atlas/Centaur vehicles through all phases of manufacturing, testing and launch. During the next four years, Atlas/Centaurs will launch five Intelsat commercial communications satellites, three High Energy Astronomical Observatory satellites, five Fleet Satellite Communications Spacecraft, and the Pioneer/Venus mission.

Teledyne Lewisburg of Tennessee has received a $531,268 contract from NASA's Marshall Space Flight Center for the production of electronic hardware items for the Space Shuttle. The contract calls for design, development, testing, fabrication, assembly, qualification testing and delivery of location aid transmitters for the Shuttle's solid rocket boosters. The transmitters will help recovery personnel on ships to locate the boosters after they have been jettisoned from the Shuttle into the ocean.

Western Union Telegraph Co. of Upper Saddle River, N.J., and **RCA Global Communications, Inc.** of New York City were selected by NASA for competitive negotiations leading to the award on December 23 of a single contract to provide tracking and data relay satellite system services for support of Earth orbital spacecraft for a 10-year period beginning in 1980. The system will consist of two specialized relay satellites in synchronous Earth orbit and ground terminal facilities located at White Sands, N.M. The spacecraft wil relay data, commands and voice to and from the ground terminal. The system will support spacecraft in Earth orbit at altitudes of at least 5,000 kilometers or 3,100 miles. The Goddard Space Flight Center manages this procurement.

The contract, for a whopping $79.6 million annually for 10 years, was won by Western Union Telegraph Corp. for its wholly owned subsidiary, Western Union Space Communications, Inc. Major subcontractors include TRW Defense and Space Systems Group, Redondo Beach, Calif., and Harris Inc. Electronics Systems Division, Melbourne, Fla.

Three companies recently were recognized for work accomplished at the Kennedy Center when they received NASA Public Service Group Achievement Awards. They are: **Stearns-Roger, Inc.** of Denver, which restored Complex 41 at Cape Canaveral following damage caused by a fire during the second Viking launch in 1975; **Greiner Engineering Sciences, Inc.** of Tampa, Fla., which developed the architecture and engineering design for the Shuttle orbiter landing facility and supervised its construction; and the **Morrison-Knudsen Co., Inc.** of Darien, Conn., which constructed the orbiter landing facility.

The Bendix Corp. of Teterboro, N.J., has been selected by the Marshall center for negotiations leading to award of a $7 million contract for work related to Space Shuttle testing. The contract calls for installation, verification, activation, reconfiguration, disassembly, transportation and removal of special test equipment and structural test articles for the Space Shuttle structural and dynamic ground tests. Tests to be conducted at the Marshall center will simulate the flight conditions that the vehicle will encounter during boost launch phases of the project.

The Solar Heating and Cooling Program, funded by ERDA, has awarded or will award 69 contracts valued at more than $37 million at the Marshall center. Of these, 37 ($27.5 million worth) are center contracts for the development of solar heating and cooling systems and subsystems in support of ERDA's demonstration program. Of the 37, 26 involve small businesses in 21 states and range in value from $5,286 to $452,109. Large businesses have received 11 of the 37 contracts; contracts are valued at from a low of $3,970 to just under $8½ million. In ERDA's commercial demonstration program, the Marshall center is managing 32 contracts valued at about $10 million. The government's share of the cost is about $7.9 million and the contractors are picking up the tab for $2 million. In each of these contracts, the contractor purchases or builds his own solar system and erects it on his building. Systems may be for hot water, heat or cooling, or any combination of the three. Located throughout the U.S. and the Virgin Islands, the systems range from one costing $6,366 for heat and hot water to a $1.6 million system for heating, cooling and hot water.

Manmade Sunshine—Sen. John J. Sparkman, second from left, inspects a solar simulator which is used by the Marshall center to produce artificial sunlight for testing solar energy collector panels. Sparkman was accompanied on a recent tour of the center's solar energy activities by Richard G. Smith (left), deputy MSFC director, Dr. Thomas McCrickard (second from right) and John Price of the Solar Heating and Cooling Project. The center is developing solar heating and cooling systems for buildings, in support of the Energy Research and Development Administration's Solar Heating and Cooling Demonstration Program.

Many Uses of Solar Energy—O. L. Smith and Wilda Davis of Marshall Center's Solar Heating and Cooling Project Office show three of many recent applications of solar energy. Smith holds a specially constructed bag which uses sunlight to heat enough water for a shower bath. Davis holds a gadget that lights a cigaret in three seconds by concentration of the Sun's rays. The third item is an outdoor grill that uses sunlight for heat, even in cold or overcast weather. When the photo was made, with the temperature at about 50 degrees Fahrenheit, the grill's thermometer showed 400 degrees and a hamburger patty was frying in the pan.

Alpha Building Corp. of Houston was chosen by the Johnson center for negotiations leading to the award of a one-year contract worth about $1⅓ million for construction support services. The services include minor construction and alteration of laboratory systems, facilities, utilities, roads, sewers, walks and other site work as required by space program requirements.

The Boeing Aerospace Co. is the recipient of a negotiated contract valued at $970,000—funded jointly by NASA and ERDA—calling for the company to provide data and support leading to the possible establishment of space-based solar power systems. The 12-month study is divided into two phases, the first five months long and the second seven months long. The solar power satellite system is envisioned as a means of providing an uninterrupted energy beam to Earth from large satellites in a fixed orbit 22,000 miles above the Earth. ■ ■ ■

Lunar Sample Exhibits

The following is a schedule of lunar sample exhibits from Dec. 15 to Jan. 15:

New Mexico—International Space Hall of Fame, Alamagordo, Sept. 27 to Dec. 31.

New York—Roberson Center Arts & Sciences, Binghamton, Jan. 3 to Feb. 27.

Texas—Houston Museum of Natural Science/History, End of Caroline at Hermann Park, Houston, Dec. 15 to Jan. 15.

American Freedom Train—Florida: Sarasota, Dec. 13-15; Palm Beach, Dec. 17-19; Ft. Lauderdale, Dec. 20-23; Miami, Dec. 26-31.

Long Term Displays

Alabama—Alabama Space & Rocket Museum, Marshall Space Flight Center, Huntsville.

Florida—Visitor Information Center, Kennedy Space Center.

Kansas—Eisenhower Library, 200 S.E. 4th St., Abilene.

Mississippi—The National Space Technology Laboratories, Bay St. Louis.

New York—United Nations Building, New York City.

Ohio—USAF Museum, Wright Patterson AFB; Visitor Information Center, Lewis Research Center.

Texas—Johnson Library, University of Texas, Austin; Visitor Information Center, Johnson Space Center, Houston.

Virginia—Visitor Information Center, Langley Research Center, Hampton.

Washington, D.C.—National Geographic Museum; Smithsonian Institution, National Air and Space Museum; Washington National Cathedral.

Inventions and Contributions Board Monetary Awards

The Inventions and Contributions Board recommended that monetary awards be granted to the NASA employees and NASA contractor employees identified below for scientific and technical contributions to space and aeronautical activities. The recommendations were approved by the Administrator and the awards have been made.

Innovator(s)	Title of Invention and Contribution
AMES RESEARCH CENTER	
Kenneth L. Orloff	Combined Dual Scatter Local Oscillator Laser Doppler Velocimeter
Ira R. Schwartz	Improvements for Abating Exhaust Noises in Jet Engines
Kenneth R. Lorell, James P. Murphy	All Sky Pointing Attitude Control System
Hubert C. Vykuka, Reginald F. King, Wilbur C. Vallotton	Anthropomorphic Master/Slave Manipulator System
John E. Greenleaf, Bill A. Williams	Thermistor Holder for Skin Temperature Measurements
Demetrius A. Kourtides, John A. Parker, Chadwick B. Delano	Low Density Polybenzimidazole Foams
Manfred N. Wirth	High Speed Data Monitoring Apparatus
James R. Rogers	Smoke Generator
James R. Rogers	Pneumatic Load Compensating or Controlling System
Thomas J. Gregory	Rotating Launch Device for Remotely Piloted Aircraft
Bill A. Williams	Head Cooling Device
Dwight L. Moody	Readout Electrode Assembly for Measuring Biological Impedance
GODDARD SPACE FLIGHT CENTER	
Ciro A. Cancro	Fast Response Lower Power Drain Switching Circuits
Donald C. Lokerson, Ronald E. Boston	Alphanumeric Character Generator for Oscilloscopes
Robert A. Kichak	Inrush Current Limiter
Henry Doong, Mario H. Acuna	Controllable High Voltage Source Having Fast Setting Time
LANGLEY RESEARCH CENTER	
Vernon L. Bell	A Method of Preparing Aeromatic Polymides
Gale A. Harvey	Apparatus for Photographing Meteors
Viggo G. Dereng	Parachute Gore Shape and Flow Visualization
LEWIS RESEARCH CENTER	
Ralph D. Thomas, William J. Nagle	Multi-Cell Battery Protection System
Christos C. Chamis, Raymond F. Lark	Hybrid Composite Laminate Structures
LYNDON B. JOHNSON SPACE CENTER	
Calvin F. Herman	Differential Pulse Code Modulation
JET PROPULSION LABORATORY	
Cyril Feldstein, Jules V. Osher, Gilbert W. Lewis, Robert H. Silver, Edward N. Duran	Muscle Displacement Transducer
Wayne E. Arens	Charge-Coupled Device Data Processor for an Airborne Imaging Radar System
Walter H. Higa	Stirling Cycle Engine and Refrigeration Systems
Robert A. Rhein, John D. Ingham	Liquid Propylene Polymers and Method of Preparation
AEROTHERM ACUREX CORP.	
William Elkins	Head Cooling Device
COLORADO STATE UNIVERSITY	
Horst E. Wilhelm	Extraction and Separation of a Preferentially Photo-Dissociated Molecular Isotope into Positive and Negative Ions by Means of an Electric Field
GENERAL ELECTRIC COMPANY	
Arthur P. Adamson	Variable Thrust Nozzle for Quiet Turbofan Engine and Method of Operating Same

HONEYWELL, INC.

Fred D. Campbell ..... Radiant Source Tracker Independent of Non-Constant Irradiance

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

David G. Jansson ..... Respiratory Protective Device

NATIONAL RESEARCH COUNCIL

Leslie D. Montgomery Readout Electrode Assembly for Measuring Biological Impedance

UNIVERSITY OF SANTA CLARA

Dah Yu Cheng ..... Noise Suppressor for Turbo Fan Jet Engine

U.S. DEPARTMENT OF AGRICULTURE

Richard R. Dedolph ... Rotary Plant Growth Accelerating Apparatus

Patents for Inventions from NASA Research

The Office of General Counsel, NASA headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.

Inventor(s) and Employer(s)	Title & NASA Docket	Patent No.	Installation
John Dimeff, NASA/ARC	Automatic Flow Control and Automatic Shut Off for Intravenous Feeders	3,989,043	ARC
Robert D. Bubois, George T. Pinson Boeing Co., Huntsville, Ala.	Guide for a Typewriter	3,989,136	MSFC
Thomas J. Gregory, NASA/ARC	Rotating Launch Device for a Remotely Piloted Aircraft	3,989,206	ARC
G. L. Fogal, General Electric Corp., Valley Forge Space Center, Philadelphia, Pa.	Fluid Mass Sensor for a Zero Gravity Environment	3,988,933	JSC
Henry W. Brandhorst, Jr., NASA/LERC	Solar Cell Assembly	3,989,541	LERC
Lee C. McCandless, Glenn E. Weber, General Technologies Corp., Reston, Va.	Method of Making Reinforced Composite Structures	3,989,602	LERC
Manfred N. Wirth, NASA/ARC	Selective Data Segment Monitoring System	3,990,049	ARC
Wayne M. Phillips, Caltech/JPL, Pasadena, Calif.	High Temperature Oxidation Resistant Cermet Compositions	3,990,860	NRLO
James R. Rogers, NASA/ARC	Smoke Generator	3,990,987	ARC
Robert H. Griswold, Jr., Carl L. Broman, General Electric Co., Cincinnati, Ohio	Dual Output Variable Pitch Turbofan Actuation System	3,994,128	LERC

Planned Launches for 1977

Name	Launch Date	Vehicle	Range	Mission Remarks
NATO-III B	Jan.	Delta	ETR	Second communications satellite in synchronous orbit to perform communications relay for NATO. Reimbursable.
Palapa-B	March	Delta	ETR	Back-up satellite for Indonesian domestic communications network. Reimbursable.
HEAO-A	April	Atlas/Centaur	ETR	High Energy Astronomical Observatory to study very energetic radiation from space.
GEOS/ESA	April	Delta	ETR	ESA spacecraft to conduct scientific investigation of waves and particles in magnetosphere. Reimbursable.

GOES-B	May	Delta	ETR	Second operational satellite to provide continuous daytime and nighttime global cloud cover observations for NOAA. Reimbursable.
OTS/ESA	June	Delta	ETR	Orbital Test Satellite. ESA experimental communications satellite. Reimbursable.
ITOS-E2	June	Delta	WTR	New generations operational meteorological satellites to provide continuous daytime and nighttime global cloud cover observations for NOAA. Reimbursable.
Intelsat IVA-C	June	Atlas/Centaur	ETR	Follow-on series of improved communications satellite for Comsat. Reimbursable.
Navy-19	June	Scout	WTR	Navy navigation satellite. Reimbursable (call-up).
GMS-A	July	Delta	ETR	Geosynchronous Meteorological Satellite. Japanese portion of global network of geostationary environmental satellites. Reimbursable.
SIRIO-A	Aug.	Delta	ETR	Italian project to investigate radio propagation, trapped radiation flux, magnetic field intensity and variation, and the primary electron energy spectrum. Reimbursable.
Meteosat	Aug.	Delta	ETR	ESA meteorological satellite. Reimbursable.
MJS-A	Aug.	Titan III Centaur	ETR	Mariner/Jupiter/Saturn mission to conduct exploratory investigation of the Jupiter and Saturn planetary systems and the interplanetary medium out to Saturn.
MJS-B	Aug.	Titan III Centaur	ETR	Same as MJS-A.
Landsat-C	Sept.	Delta	WTR	Third Earth resources technology satellite.
RCA-C	Sept.	Delta	ETR	Third domestic communications satellite for RCA. Reimbursable.
Intelsat IVA-D	Oct.	Atlas/Centaur	ETR	Follow-on series of improved communications satellites for Comsat. Reimbursable.
ISEE-A/B	Oct.	Delta	ETR	International Sun-Earth Explorer. Joint NASA/ESA mission to study the interaction of the interplanetary medium with Earth's immediate environment, the magnetospheric bow shock and magnetosheath, and measure the characteristics of the interplanetary medium away from Earth's perturbing influence.
FltSatcom-A	Oct.	Atlas/Centaur	ETR	Navy Fleet Satellite Communications. Reimbursable.
UK-6	Oct.	Scout	WTR	Measure ultra-heavy cosmic ray particles and study low-energy cosmic X-rays and the fast secular behavior of X-ray sources Reimbursable.
CS-A	Nov.	Delta	ETR	Provide communication coverage of Japan for both telephone and color TV transmission and experiments. Reimbursable.
OTS	Dec.	Delta	ETR	ESA experimental communications satellite. Reimbursable.
IUE-A	Dec.	Delta	ETR	International Ultraviolet Explorer-cooperative with ESA. Obtain high resolution data of stars and planets in the ultraviolet region of the spectrum.
Navy-20	Dec.	Scout	WTR	Navy navigation satellite. Reimbursable (call-up).

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A Way of Preventing Atrophy in Injured Fingers

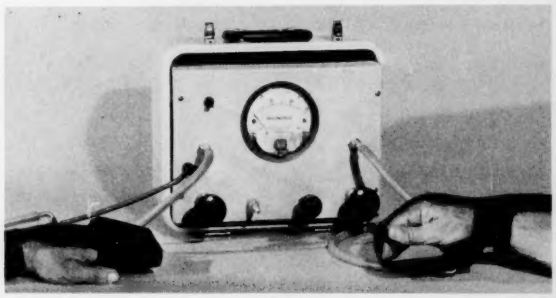
Technology developed on airflow at NASA's Langley Research Center has led to the development of a unique rehabilitation device to aid people whose hands have been immobilized for long periods. Developed by Langley engineer Donald E. Barthlome, the appliance is a pneumatically operated mitten that fits over an immobilized hand and automatically flexes the patient's fingers. Astronaut space suits inspired the medical invention.

The finger flexer is important because it can prevent permanent immobilization of joints in hands, which can result from injury, disease, surgery or prolonged exposure to severe heat or cold. The therapy, which can be self-conducted, permits the patient to control the rate of flexing and turn the machine off and on at will. An important advantage of the treatment is that the many hours a trained therapist ordinarily must devote to daily manual manipulation of injured fingers are considerably reduced. In addition, the patient can control the rate of finger movement and stop pain whenever he chooses, an important psychological advantage and often an encouragement to operating the machine to work the affected joints for progressively longer periods. The self-control feature, in cases so far observed, has saved about 50 percent of a therapist's time, thus doubling productivity.

A non-exclusive patent license has been issued by NASA to Bardon Enterprises, Inc. of Hampton, Va., for commercial production of the flexer. The basic single-mitten system can be used at home. A two-mitten hospital version that allows simultaneous use by two patients has been produced but is not yet for sale. It will probably cost less than $300.

Development of the device was sponsored by NASA's Office of Technology Utilization through the Langley center's technology utilization officer John Samos. The cooperative effort involved research and development by the Biomedical Applications Team of the Research Triangle Institute at North Carolina. Team director Dr. Richard W. Scearce and occupational therapist Irene Hollis, of the Rehabilitation Center at the University of N.C. Medical School, repeatedly tested the device and evaluated its effectiveness. The experimenters agree that more extensive usage of the flexer may be possible and they plan additional research into the matter.

NASA does not endorse commercial products developed as a result of its research, but it does encourage the widest possible use of its technology.



Therapy for Impaired Joints—A clinical model of a finger flexer is shown operating both the extendor glove (left) and the flexer glove (right). The model can treat two patients at once. The extendor glove operates to straighten or unclench fingers in which deteriorative injuries to joints have caused a stiffening of fingers into a clawlike position. The flexer glove contains an inflatable cushion under the palm of the hand. Attached to the wrist-strap, the cushion causes stiffened fingers to clench and unclench—or flex—as it inflates and deflates by pneumatic action. Though heavier than a single-user appliance also in use, this model is portable.

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